DOCUMENT RESUME

ED 397 706 HE 029 306

AUTHOR Einarson, Marne K.; Santiago, Anna M.
TITLE Background Characteristics as Predictors of Academic Self-Confidence and Academic Self-Efficacy among Graduate Science and Engineering Students: An Exploration of Gender and Ethnic Differences. AIR 1996 Annual Forum Paper.
PUB DATE 7 May 96
NOTE 59p.; Paper presented at the Annual Forum of the Association for Institutional Research (36th, Albuquerque, NM, May 5-8, 1996).
PUB TYPE Speeches/Conference Papers (150) -- Reports - Research/Technical (143)

EDRS PRICE MF01/PC03 Plus Postage.
DESCRIPTORS *Academic Achievement; Career Planning; Engineering Education; *Ethnic Groups; Foreign Students; Graduate Students; Higher Education; Minority Groups; Models; Predictor Variables; Science Education; *Self Efficacy; *Self Esteem; *Self Evaluation (Individuals); *Sex Differences; Socioeconomic Status; Student Characteristics
IDENTIFIERS *AIR Forum

ABSTRACT

Gender and ethnic differences in, and possible predictors of, academic self-confidence, academic self-efficacy, and career-related outcome expectations were investigated for 289 students entering graduate programs in engineering and physical sciences at a research university in the midwestern United States. Influence of student demographic characteristics and parental socioeconomic characteristics, the differences in prior academic performance and program-related work experience, expectations of faculty/student interactions, perceptions of gender and ethnic status as admissions influences, and controls for current degree level and other factors were estimated hierarchically. Women reported lower academic self-confidence than men, but gender was only marginally predictive of academic self-efficacy and did not enter into models predicting career-related outcome expectations. U.S. minority students reported higher academic self-efficacy than Anglo students, and foreign student status was associated with reduced career-related outcomes. Student perceptions of academic preparedness, status-related disadvantages, and faculty/student interactions were strong predictors of academic self-efficacy and career-related outcome expectations. Student funding concerns and research group involvement contributed to reduced career-related outcome expectations. Findings suggest that social, cognitive, and institutional variables may be important determinants of subsequent academic performance. Eight tables giving a statistical breakdown of the various factors studied and two appendices offering comparative statistics and variable definitions are included. (Contains 69 references.) (Author/CK)

ED 397 706

BACKGROUND CHARACTERISTICS AS PREDICTORS OF ACADEMIC SELF-CONFIDENCE AND ACADEMIC SELF-EFFICACY AMONG GRADUATE SCIENCE AND ENGINEERING STUDENTS: AN EXPLORATION OF GENDER AND ETHNIC DIFFERENCES

Marne K. Einarson and Anna M. Santiago
University of Michigan
Center for the Education of Women
330 E. Liberty
Ann Arbor MI 48104-2289
313/998-7080
313/998-6203

Paper presented at the 36th Annual Forum of the Association for Institutional Research, Albuquerque NM (May 7, 1996).

ACKNOWLEDGEMENTS: This research was partially supported by a grant from the Alfred P. Sloan Foundation to the Women in Science and Engineering Project at the Center for the Education of Women, University of Michigan, whose support is gratefully acknowledged. Special thanks to Rebecca Pacheco, Sonia Park, Yolonda Riley, Ana Santiago and Monica Tijerina for their research assistance on this project.

BEST COPY AVAILABLE

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)
✓ This document has been reproduced as received from the person or organization originating it.
☐ Minor changes have been made to improve reproduction quality.
• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL HAS BEEN GRANTED BY
AIR
TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

HE 029 306

AIR

for Management Research, Policy Analysis, and Planning

This paper was presented at the Thirty-Sixth Annual Forum of the Association for Institutional Research held in Albuquerque, New Mexico, May 5-8, 1996. This paper was reviewed by the AIR Forum Publications Committee and was judged to be of high quality and of interest to others concerned with the research of higher education. It has therefore been selected to be included in the ERIC Collection of Forum Papers.

Jean Endo
Editor
AIR Forum Publications

Abstract

Gender and ethnic differences in, and possible predictors of, academic self-confidence, academic self-efficacy, and career-related outcome expectations were investigated for 289 students entering graduate programs in engineering and physical sciences at a research university. Women reported lower academic self-confidence than men, but gender was only marginally predictive of academic self-efficacy and did not enter into models predicting career-related outcome expectations. U.S. minority students reported higher academic self-efficacy than Anglo students. Foreign student status was associated with reduced career-related outcomes. Student perceptions of academic preparedness, status-related disadvantages, and faculty/student interactions emerged as strong predictors of academic self-efficacy and career-related outcome expectations. Student funding concerns and research group involvement contributed to reduced efficacy and career-related outcome expectations. Given the relative equivalence of entering student profiles across status groups, findings suggest that social cognitive and institutional variables may be important determinants of subsequent academic performance.

Introduction

Despite increases in the percentage of women and minority students in graduate science and engineering programs, relative progress in achieving gender and racial parity in representation and performance continues to lag behind that achieved in other academic fields (Barber, 1995; Lomperis, 1990; National Science Foundation, 1995; Zwick, 1991). While the disproportionate loss of women and minority students is of concern at all stages of the science and engineering pipeline, the graduate school years have been identified as a major point of gender and racial/ethnic disparity (Adams, 1993; Clewell & Ginorio, 1996; Hurtado, 1994; Widnall, 1988). Relative to their Anglo male counterparts, women and minority graduate students have lower degree completion rates (Adams, 1993; Mooney, 1969; Zwick, 1991), longer degree completion times (Bowen & Rudenstine, 1992; Sotello Viernes Turner & Thompson, 1993), and are more likely to stop their graduate studies after acquiring a Master's degree (Hollenshead, Wenzel, Lazarus & Nair, 1996; Schroeder & Mynatt, 1993; Widnall, 1988). This differential performance of women and minorities in graduate science and engineering education has far reaching consequences for their subsequent representation within science and engineering fields, generally, and within the academy, specifically (Barber, 1995; Brush, 1991; Widnall, 1988).

The undergraduate science and engineering literature is replete with studies exploring differences in student participation, performance and persistence between men and women, and more recently, between majority and minority students in these fields (see for example, Felder, Felder, Mauney, Hamrin & Dietz, 1995; Hackett, Betz, Casas & Rocha-Singh, 1992; Jagacinski & LeBold, 1981; Olstad, Juarez, Davenport & Haury, 1981). Of particular interest to our study, research conducted at this level suggests that social cognitive factors, rather than differences in objective measures of academic aptitude or ability, may contribute to the decisions of women and minority students to leave science and engineering (Astin & Sax, 1994; Hurtado, 1994; Seymour & Hewitt, 1994). Two constructs, academic self-confidence and academic self-efficacy, have received attention, both as outcomes of college attendance, and as mediating influences on students' academic

achievement (Brown, Lent & Larkin, 1989; Hackett et al., 1992; Lent, Brown & Larkin, 1986; Pascarella, Smart, Ethington & Nettles, 1987; Shavelson & Bolus, 1982; Shavelson, Hubner & Stanton, 1976).

There has been comparatively little research focused on the academic self-confidence of students in graduate science and engineering programs, and virtually none pertaining to academic self-efficacy. Therefore, the extent to which these constructs remain operative at this educational level, and whether related gender or ethnic differences exist, remain largely unexplored. This study seeks to extend the current literature on academic self-confidence and academic self-efficacy by addressing the following research questions: 1) Are there gender or ethnic differences in academic self-confidence and academic self-efficacy among students entering graduate programs in the physical sciences and engineering? 2) Do student background characteristics predict academic self-confidence and academic self-efficacy as reported at the onset of graduate studies?

Review of the Literature

Academic Self-Confidence

Various authors have employed the terms academic self-confidence (Berg & Ferber, 1983; Felder et al., 1995; Hornig, 1987), academic self-concept (House, 1992, 1993; Hurtado, 1994; Pascarella et al., 1987; Sax, 1994; Shavelson & Bolus, 1982) and self-esteem (Brush, 1991; Widnall, 1988), sometimes even within the same study (see for example, Astin & Sax, 1994) to refer to students' self-perceptions of their academic abilities. For the purposes of this study, we will use the term academic self-confidence to refer to this theoretical construct. Academic self-confidence has generally been operationalized in the undergraduate literature by asking students to rate their academic abilities, separated into discrete scale items such as math, writing, overall academics, computer skills, etc., relative to the abilities of their peers (Astin & Sax, 1994; House, 1992; Pascarella et al., 1987; Sax, 1994; Shavelson et al., 1976).

Research conducted at the undergraduate level has shown that despite objective evidence of equivalence in prior academic aptitude and performance, entering women and minority science and

engineering students have lower academic self-confidence than their Anglo male peers (Alper, 1993; Berg & Ferber, 1983; Felder et al., 1995; Frieze & Hanusa, 1984; Jackson, Gardner & Sullivan, 1993). Further, for most women, this gender gap in academic self-confidence increases over the course of the undergraduate years (Jagacinski & LeBold, 1981; Maccoby & Jacklin, 1974; Ott, 1978).

Two studies of graduate science and engineering students reported significant gender differences, favoring males, in students' academic self-confidence (Etzkowitz, Kemelgor, Neuschatz & Uzzi, 1992; Zappert & Stansbury, 1984). Focusing on Chicano and black students across a variety of graduate programs, Hurtado (1994) found similar gender differences in students' academic self-confidence, as reported at time of program entry and in a follow-up survey nine years later.

Academic Self-Efficacy

Relative to academic self-concept, the conceptualization and measurement of academic self-efficacy is more complex. Academic self-efficacy refers to an individual's expectations of success in relation to the completion of specific academic tasks (Lent, Brown & Larkin, 1986). Derived from Bandura's (1977, 1982) social cognitive theory, self-efficacy consists of self-expectations about efficacy and outcomes. Efficacy expectations refer to an individual's beliefs about his/her ability to successfully perform a required behavior. When the term academic self-efficacy is employed in the literature, this is the element of self-efficacy theory that is typically operationalized (see for example, Brown et al., 1989; Lent et al., 1986). Outcome expectations, meaning an individual's beliefs about the specific consequences that will result from successful task completion, are a distinctive component of self-efficacy theory. According to Bandura, both kinds of expectations are important in producing and sustaining task-related behavior. For the sake of consistency, we will use the term academic self-efficacy to refer specifically to efficacy expectations and will reserve the term outcome expectations for individual beliefs about the consequences associated with task completion.

The operationalization of academic self-efficacy within the research literature is somewhat problematic. Of greatest concern has been the specificity of scale items, and their correspondence to the performance domain under consideration (Owen & Froman, 1988; Pajares, 1996). For the

purposes of predicting academic achievement and persistence, measures of academic self-efficacy that require students to rate their ability to complete program-related academic tasks have received support in the research literature (Brown et al., 1989; Lent et al., 1986). Despite Bandura's (1986) contention that negative outcome expectations undermine the effects of strong efficacy expectations on the persistence of task-related effort, few studies have included outcome expectations in the measurement of academic self-efficacy (Hackett et al., 1992).

Issues of conceptualization and measurement notwithstanding, academic self-efficacy has been associated with achievement and persistence among undergraduate science and engineering students (Brown et al., 1989; Hackett et al., 1992; Lent et al., 1986). Moreover, there is some evidence of ethnic and gender differences in this regard. Hackett et al. (1992) found ethnic status (being Euro-American versus Mexican-American) to be predictive of academic self-efficacy expectations. While Brown et al. (1989) and Hackett et al. (1992) did not uncover gender differences in students' academic self-efficacy expectations, Hackett et al. (1992) reported that women had less positive expectations of the likely consequences of completing a science and engineering degree compared to men, and positive outcome expectations were predictive of students' academic self-efficacy. In a similar vein, Jackson et al. (1993) found that relative to male peers, women students were more concerned about the difficulties of combining career and family responsibilities, and that next to freshman grade point average, expected salary after degree completion was the strongest predictor of undergraduate engineering persistence for women.

Zappert and Stansbury (1984) reported gender differences, favoring males, in self reports of efficacy among graduate science, engineering and medical students. However, their operationalization of this construct was not consistent with the conceptual literature or with explorations of self-efficacy conducted at the undergraduate level. Women were more likely than men to anticipate having difficulties integrating work and family life demands. This study appears to be the only attempt to examine self-efficacy at the graduate level.

Antecedents of Academic Self-Confidence and Academic Self-Efficacy

Self-efficacy is conceived as being self-perpetuating to some degree, in that individuals with strong self-efficacy are likely to persist in a given behavior long enough to receive positive consequences which then serve to bolster their self-efficacy (Bandura 1977; 1982). However, a change in task demands, or switch to a different context for task performance can trigger new self-efficacy appraisals (Estes, 1972). Further, Bandura (1982) posits that self-efficacy is a better predictor of future task behavior than past task performance, abilities or aptitude. Taken together, the conceptual and empirical literature suggest that even in a cohort of intellectually homogeneous graduate students with records of successful prior academic performances, entering students' academic self-confidence and academic self-efficacy appraisals may vary, and that consequently, their graduate academic performance may differ. In view of the intervening functions ascribed to these constructs, it seems useful to explore whether and to what extent student background characteristics are predictive of academic self-confidence and academic self-efficacy as reported at the onset of graduate studies.

A review of the persistence literature offers guidance about entering student variables that may also function as antecedents of academic self-confidence and academic self-efficacy. Several parallels exist between entering student characteristics viewed as operative in academic persistence and performance at the undergraduate and graduate levels. These are parental socioeconomic status, as indicated by educational attainment and occupational status, considered separately for mothers and fathers, and parental income (Astin & Sax, 1994; Isaac, Malaney & Karras, 1992; Jagacinski, LeBold & Linden, 1987; Hurtado, 1994; Peng & Jaffee, 1979; Seymour & Hewitt, 1994; Tinto, 1993); and prior academic achievements, including undergraduate grade point average (Girves & Wemmerus, 1988; Hurtado, 1994; Tinto, 1993), and students' perceptions of the extent to which their prior education has prepared them for their current program of study (Astin & Sax, 1994; Zappert & Stansbury, 1984).

Distinctive from the undergraduate experience, conceptual models of graduate student degree progress proposed by Tinto (1993) and Girves and Wemmerus (1988) suggest that consideration must also be given to the extent of graduate students' external, nonacademic responsibilities (Etzkowitz et al., 1992); amount and type of financial support (Adams, 1988; Hollenshead et al., 1996; Syverson, 1982; Syverson & Forster, 1983; Widnall, 1988); and the quantity and quality of student interactions with faculty (Berg & Ferber, 1983; Etzkowitz et al., 1992; Hurtado & Carter, 1994; Nerad & Stewart, 1991; Schroeder & Mynatt, 1993; Widnall, 1988).

In her study of minority graduate students, Hurtado (1994) reported that parental socioeconomic status had a positive direct effect on academic self-confidence at entry, and a small indirect effect on later academic self-confidence. Further, entering levels of academic self-confidence both directly affected, and mediated the effect of socioeconomic status, on students' subsequent academic self-confidence appraisals. Hurtado's study appears to offer the only empirical evidence of relationships among these variables available at the graduate level.

Despite the demonstrated influence of academic self-confidence and academic self-efficacy on academic performance and persistence of undergraduate science and engineering students, these constructs are viturally absent in graduate-level research. Further, while researchers acknowledge the importance of ethnicity variables on graduate student achievement and persistence in science and engineering, both as independent influences and in interaction with gender (Malcom, 1989; Malcom, Hall & Brown, 1976), the underrepresentation of minority students in graduate science and engineering has generally not permitted this level of analysis (Girves & Wemmerus, 1988; Hackett et al., 1992; Hollenshead et al., 1996; Hornig, 1987; Malaney, 1988). Finally, the participation, persistence and achievement of women and minorities varies considerably by field of graduate study (Brush, 1991; Hornig, 1987; Malaney, 1988; National Science Foundation, 1995), yet existing studies have tended to aggregate results across graduate departments (see, for example, Girves & Wemmerus, 1988; Hurtado, 1994; Mellow & Goldsmith, 1988), thus failing to reveal possible field-specific influences on student performance and persistence.

Purpose of Study

In the present study, we begin to address these research gaps by investigating (a) gender and ethnic differences in academic self-confidence and academic self-efficacy of students entering graduate physical science and engineering programs at a research university and, (b) the extent to which selected student background characteristics are predictive of entering academic self-confidence and academic self-efficacy appraisals . We do not argue that individual factors are solely responsible for the lower participation and success rates of women and minority students in graduate science and engineering but rather, that these entering characteristics may be important beginning pieces in a much larger puzzle. Results obtained may prove useful in the early identification of students at risk of attrition, and suggest programmatic interventions that could be implemented both prior to, and during, the first year of graduate education to improve the persistence and performance of vulnerable students.

Methods

The data for this study were drawn from the first wave of the Graduate Experience Project, a longitudinal study tracking the educational experiences of students enrolled in graduate engineering and physical sciences programs at a major research university in the Midwest. (For a more complete description of the study and our sample, see Santiago & Einarson, 1996.) At the beginning of the Fall 1995 semester, the entering cohort of graduate students enrolled in engineering, chemistry, physics and applied physics (N = 590) was sent a mail-back questionnaire that inquired about previous education and work experience, entering enrollment information, expectations of graduate program, anticipated outcomes, and demographic information. Completed surveys were received from 289 students, representing a 49% response rate.

A comparison of selected characteristics reveals few differences between the sample and total entering cohort (refer to Appendix A). Proportionally, women are slightly overrepresented in the sample compared to the cohort while engineering students and international students are slightly underrepresented. In view of the large proportion of international students in the cohort and sample, we decided to analyze results separately for majority, U.S. minority, and foreign students. As data

collection continued between September 1995 and January 1996, we examined differences in characteristics between early and later respondents. Compared to earlier respondents, later respondents were more likely to indicate being a member of a research group and less likely to expect to find a field-related job upon completion of their graduate program.

Model Specification

This study explores differences among, and possible predictors of, entering graduate students' academic self-confidence and academic self-efficacy. Consistent with Bandura's theory (1977, 1982, 1986), we conceptualized self-efficacy in terms of student confidence in the ability to complete program requirements as well as their expectations regarding four possible employment outcomes at time of graduate degree completion: chances of finding a field-related job; expected annual earnings; opportunities for career advancement; and likelihood of experiencing conflict between family and work demands. We hypothesized that academic self-confidence and academic self-efficacy, as well as outcome expectations might be related to student demographic characteristics, parental socioeconomic characteristics, undergraduate performance and preparation, post-baccalaureate work experience, expectations about the graduate academic environment, and institutional factors, such as enrollment and funding status, and initial involvement in the department. A complete listing of variables and definitions is presented in Appendix B.

Previous studies examining gender and ethnic differences in graduate-level performance (Felder et al., 1995; Hackett et al., 1992; Hollenshead et al., 1996; Zwick, 1991; Zappert & Stansbury, 1984) lead us to anticipate that women and U.S. minority students will report less academic self-confidence, weaker academic self-efficacy, and reduced expectations regarding employment, earnings, and career advancement relative to their Anglo male peers. We expect women to have greater concerns than men about the likelihood of encountering family/work conflicts. Since international students are subject to greater competition in terms of admission, they are expected to report greater academic self-confidence and self-efficacy than U.S. students. However, reflective of likely employment conditions within the U.S. and their countries of origin, they may be less positive in their employment-related

expectations. In addition, given the potential for competing demands upon available time and reduced access to department information, we expect that married and employed students might have lower academic self-confidence and self-efficacy, and anticipate family/work conflicts. However, current employment may be predictive of higher academic self-confidence, academic self-efficacy, and optimism about future employment, earnings, and career advancement.

While less influential at the graduate level than the undergraduate level, parental socioeconomic attributes are expected to be positively related to students' academic self-confidence (Hurtado, 1994), self-efficacy, and outcomes expectations. Further, based upon the undergraduate literature (Isaac et al., 1992; Seymour & Hewitt, 1994), we anticipate that these variables will be stronger predictors for female students.

Undergraduate academic performance and perceptions of the adequacy of undergraduate preparation are hypothesized to predict higher levels of all outcome measures, except for expectations of family/work conflict. We expect that students entering with master's degrees and related work experience will be more confident about their academic abilities, their chances of successful program completion, and anticipated career outcomes.

Students who have positive expectations of faculty/student interactions, and those who perceive their race and gender as assets to admission are likely to report higher academic self-efficacy (Berg & Ferber, 1983) and more positive career-related outcomes. However, we do not expect these expectations and perceptions to predict academic self-confidence. That is, these students will not rate their academic abilities higher than those of their peers, but they may be more optimistic about receiving support from faculty and their department in terms of successfully negotiating degree requirements and obtaining employment (Girves & Wemmerus, 1988).

Finally, we expect that institutional factors such as type of degree, degree program, departmental involvement and funding to influence academic self-confidence, academic self-efficacy, and anticipated employment outcomes. Doctoral students are anticipated to be more confident about their academic ability, chances of successful degree completion, and outcomes expectations, relative

to students enrolled at the master's degree level. Having a faculty mentor and membership within a research group may not predict academic self-confidence, but may be positively related to academic self-efficacy and outcomes expectations (Hollenshead et al., 1996; Widnall, 1988; Zappert & Stansbury, 1984). Students with funding concerns are not expected to be less confident about their academic abilities per se, but are expected to be less confident about completing their degree requirements (Tinto, 1993), and obtaining field-related, and well-paying employment (Hollenshead et al., 1996).

Five models are estimated for each of the outcome variables of interest. Model 1 tests the influence of student demographic characteristics. Model 2 adds parental socioeconomic characteristics. Model 3 controls for differences in prior academic performance and program-related work experience. In Model 4, we introduce expectations of faculty/student interactions and perceptions of gender and ethnic status as admission influences. Model 5 adds controls for current degree level, program affiliation, involvement with faculty and research group, and funding concerns. The models are estimated hierarchically.

Results

Entering Characteristics Of Students By Gender, Ethnicity, And Resident Status

As may be expected in a highly selective institution, a comparison of entering characteristics across gender, ethnic, and resident status groups, as shown in Table 1, revealed more commonalties than differences. There were similar patterns of student marital and employment status, and parental socioeconomic attainment across groups. Few differences were apparent in students' academic credentials and post-baccalaureate training and work experience. Overall scale scores reflecting student expectations about faculty/student interactions in their graduate program were quite uniform across groups. Finally, in terms of current enrollment characteristics, the groups were comparable in the extent to which they were registered for a doctoral degree, were enrolled in engineering versus physical science, had a mentor in the program, belonged to a research group, and were concerned about their ability to pay for their graduate education.

-- Table 1 about here --

However, statistically significant differences across groups were apparent on three dimensions: scores on the Graduate Record Exam, and students' perceptions of whether their gender and ethnic status functioned as an asset or liability in their admission to graduate school. As may be anticipated, international men and women had lower GRE verbal scores than their Anglo counterparts. Consistent with the extant literature (Zappert & Stansbury, 1984)), women's GRE quantitative scores were lower than those achieved by men (720 versus 755).

Less expected, however, were the differences found in students' perceptions of the positive or negative effects of their gender and ethnicity. While 41% of women felt their gender to be an asset in admissions decisions, less than 2% of men expressed this view. This disparity in perceiving one's gender as an asset was most pronounced between Anglo women and Anglo men (60% versus 0%) and minority women and men (50% versus 4.2%). In a similar vein, no women reported feeling that their gender was a liability in being admitted to graduate school, compared to approximately 12% of Anglo and minority men indicating that being male had disadvantaged their chances of admission.

Male and female minority students were most likely to perceive their ethnicity as an asset to admission; however, differences across groups were not significant. No women reported their ethnic status to be a liability, while approximately 12% of Anglo males and 22% of minority males were of the opinion that their ethnic status had a negative effect on their admission to graduate school. Juxtaposed with objective information about the continued underrepresentation and lower success rates of women and minorities in graduate level science and engineering, this perception among Anglo males of being a comparatively disadvantaged group is a finding that is both intriguing and somewhat troubling, in light of its possible implications for student interactions within programs.

-- Table 2 about here --

Outcome Measures By Gender, Ethnicity, And Resident Status

Given the hypothesized importance of perceptions of abilities and the anticipated consequences of degree completion upon academic persistence and performance, we were interested in establishing

a baseline of students' beliefs in both regards and in comparing these measures across gender, ethnic and resident status groups. These results are presented in Table 2.

With the exception of academic self-confidence and expectations of limited opportunities for career advancement, there were no significant differences found across all groups. Consistent with our expectations and previous studies of undergraduate and graduate science and engineering students (Astin & Sax, 1994; Etzkowitz et al., 1992; Felder et al., 1995; Zappert & Stansbury, 1984), our male respondents expressed greater confidence in their academic abilities than did the females (41.8% versus 38.7%). Foreign men were more likely than Anglo men to anticipate having limited opportunities for advancing within their field (39% versus 10.4%). This may reflect the reality of constrained employment opportunities in foreign students' countries of origin, and their comparatively reduced chances of obtaining employment in the United States.

Contrary to our hypothesis, there were no differences in academic self-efficacy expectations found across groups. Aside from foreign versus Anglo males' expectations of career advancement, there were no differences by gender or ethnicity in students' perceptions of likely career outcomes upon graduate degree completion. As we expected, foreign students anticipated earning lower annual salaries than minority or Anglo students, but this difference was not statistically significant. This relative uniformity of outcome expectations is in contrast to previous studies (Hackett et al., 1992; Jackson et al., 1993) in which male undergraduate engineering students were found to hold more positive outcome expectations than their female peers.

Predictors of Outcome Measures

The second major thrust of our study was to examine the degree to which characteristics of entering students were predictive of their performance on the dependent variables, and whether differences in predictors occurred across gender or ethnic lines. We employed hierarchical OLS regression to examine the predictors of academic self-confidence, academic self-efficacy, and expected annual earnings after degree completion. Hierarchical logistic regression was used to predict expectations of finding a field-related job, having limited opportunities for career advancement, and

experiencing conflicts between family and work commitments. In our presentation of logistic regression results, we use the antilogs of the unstandardized regression coefficients. The antilog represents the unit change in the odds of Y occurring given a unit change in X. The results of our regression models appear in Tables 3 through 8.

--Table 3 about here --

Academic Self-Confidence

Table 3 displays the OLS regression results for the models predicting academic self-confidence. The full model accounted for 17% of the variance in this dependent measure. Overall, students' undergraduate grade point average was the strongest positive predictor of academic self-confidence, followed by students' self-ratings of the extent to which their undergraduate education prepared them for their graduate program. For each point increase in undergraduate grade point average, we would expect a 4.4 point higher rating of academic self-confidence. Students who felt academically well prepared for their graduate program had academic self-confidence scores that were 3.6 points higher relative to peers who felt less well prepared. These findings of a predictive relationship between prior academic performance and current academic self-confidence are consistent with similar studies at the undergraduate level (Astin, 1993; Pascarella et al., 1987). Students who were employed over the 1995-96 academic year had academic self-confidence scores that were 3 points higher than those who were not employed. We suggest this relationship may be due to the enhanced opportunities for employed students to integrate theoretical and practical knowledge. Finally, students enrolled in engineering reported academic self-confidence 2.8 points higher than students in the physical sciences.

The only factor that predicted reduced academic self-confidence was gender, with women rating their academic abilities 3.4 points lower than men. It is important to note that this predictive relationship was sustained quite consistently across all five models, and persisted even after controlling for undergraduate preparation. As discussed above in relation to Table 2, this reinforces the findings of previous studies, and suggests that academic self-confidence continues to be an important gender issue in graduate science and engineering education.

-- Table 4 about here --

Academic Self-Efficacy

The full model, shown in Table 4, accounted for almost 25% of the variance in student ratings of academic self-efficacy. Of those variables positively related to self-efficacy, student self-ratings of the adequacy of undergraduate preparation emerged as the strongest predictor. As anticipated, students who felt academically well-prepared had academic self-efficacy scores 1.8 points higher than student who felt less adequately prepared. Interestingly, undergraduate grade point average was negatively, albeit insignificantly, related to academic self-efficacy. While appearing contradictory at first glance, these combined results offer tentative support to the tenet of self-efficacy theory that successful past performance does not automatically equate to strong self-efficacy in a new setting. Rather, what seems to matter is whether individuals believe they possess abilities relevant to the new performance context. Minority status was the second strongest predictor of academic self-efficacy, a result that runs counter to our expectations and previous research by Hackett et al. (1992). U.S. minority students had academic self-efficacy scores that were 1.7 points higher than those of majority and foreign students. This finding is somewhat curious in view of the fact that on average, minority men and women entered their graduate programs with lower GRE verbal and math scores than non-minority students, and that as a group, minority men were least likely to report that their undergraduate education had adequately prepared them for graduate school. While not testable on the basis of the present data, these results lend support to Hurtado's (1994) suggestion that minority graduate students develop adaptive cognitive strategies to maintain their sense of self-worth .

Students who expected more positive faculty/student interactions in their program had higher academic self-efficacy than their less optimistic peers. For every point increase in faculty/student interaction rating, there was a .1 increase in academic self-efficacy scores. This fits with our expected findings, and supports the importance accorded to these relationships in the literature (Berg & Ferber, 1983; Girves & Wemmerus, 1988). Students from upper class socioeconomic backgrounds had academic self-efficacy scores 1.2 points higher than students of middle or working class social origins.

This finding is in keeping with research conducted at the undergraduate and graduate level (Astin & Sax, 1994; Jagacinski et al., 1987; Hurtado, 1994; Seymour & Hewitt, 1994). Finally, students who were married or living with a partner rated their academic self-efficacy .9 points higher than those students who lived alone, with their family of origin, or roommates. This finding is contrary to our expectations and those of the extant literature which suggests that marital commitments may compete with students' academic responsibilities (Nerad & Stewart, 1991; Tinto, 1993). Rather, narrative comments collected as part of our questionnaire indicate that married and cohabiting students receive emotional support and a sense of balance from their intimate relationships.

As for factors linked to decreases in academic self-efficacy, the strongest predictor by far was the perception of race as a liability to admission. Students who felt disadvantaged by their race had academic self-efficacy scores 3.4 points lower than those who did not feel similarly disadvantaged. While tests of significance revealed minority men and Anglo men to be most likely to perceive their race as a liability, the operation of minority status as a positive predictor of academic self-efficacy in this model suggests that, when it comes to academic self-efficacy, it may be Anglo males who feel most disadvantaged in terms of successfully negotiating degree completion. The fact that Anglo men have greater confidence in their academic abilities but less confidence in their ability to complete their graduate program suggests that these men may perceive that factors other than academic ability determine actual degree completion. Just what these factors may include, in their view, warrants further exploration.

As was anticipated, students with concerns about their ability to finance their education reported lower academic self-efficacy (by 2 points) than students who did not report funding concerns. This finding supports the conceptual literature on graduate student persistence (Girves & Wemmerus, 1988; Tinto, 1993). Students with college-educated mothers were less confident about completing their degree program. We can only speculate that this finding reflects the possibility that these sons and daughters have been given more information about the difficulties associated with graduate study. Finally, in the reduced-form equation, gender entered as a relatively weak but significant predictor in

the equation, with females reporting academic self-efficacy scores that were 1 point lower than males. This supports our expectations, but conflicts with existing undergraduate research results (Brown et al., 1989; Hackett et al., 1992) that found no gender differences in academic self-efficacy.

-- Table 5 about here --

Outcome Expectations

Expected annual earnings.

The regression model predicting expected annual earnings is displayed in Table 5.In terms of variables predictive of expecting higher annual earnings, students who perceived of their race as an admissions liability (which includes minority and Anglo men) expected to earn $10,040 more per year than students who viewed their race as either being an asset or having had no effect on admissions. Students enrolled in engineering programs expected annual earnings that are $7643 higher than those anticipated by students in physical sciences. Married or cohabiting students expected to earn $3965 more per year than their single counterparts. Enrollment in a doctoral degree program was predictive of expecting to earn $2192 more per year than was anticipated by master's degree students. Finally, students who expected to experience positive faculty/student interactions were also more optimistic about their annual salaries, expecting to earn $401 more per year for each point increase in the faculty/student interaction rating scale. For the most part, these results are intuitive. It makes sense that doctoral students would expect higher earnings than master's students, that students who are optimistic about faculty interactions might also be more hopeful about their eventual earnings, that engineering students might expect to command higher salaries, and that students with committed relationship responsibilities might at least hope or need to earn higher incomes than their single peers. The finding that minority and Anglo males who felt that their racial status was a detriment to program admission also expected to earn a higher salary than other groups will be considered further below.

Students who perceived of their gender as a liability to admissions (again, this signifies Anglo and minority males) expected to earn $10,351 less per year than students who did not feel similarly disadvantaged. This result is interesting to consider in light of the above finding that Anglo and

minority males who felt racially-disadvantaged in their admissions process expected higher earnings. Further research is definitely needed to disentangle the dynamics that underlie these somewhat puzzling results. At this point we surmise that it may be Anglo males, in particular, who feel comparatively disadvantaged in terms of career outcomes. While Anglo males, on average, expected the highest earnings of any student group in our sample, those who felt that their gender and racial status disadvantaged their chances of admission to graduate school may also feel that their chances of earning a high salary are similarly diminished.

Having a mother who is a scientist or engineer was predictive of expecting to earn $7315 less per year. It may be that these students have a more realistic appraisal of the salary structure in these professions because of their familial exposure. Foreign students expected to earn $6592 less per year than Anglo students. As discussed previously, this is likely an accurate reflection of different career opportunities in their countries of origin. Finally, students who have a departmental mentor in the current academic year anticipated earning $5850 less per year than students who do not have a mentor. We suggest that this counterintuitive result may be due to mentored students being given a more realistic, if perhaps less optimistic, view of the professional salary structure. In addition, students with faculty mentors may be more likely than nonmentored students to consider eventual employment within the academy. Relative to salaries in industry, faculty salaries are generally lower.

-- Table 6 --

Expectations of finding a field-related job.

The logistic regression results of the models predicting students' expectations of finding a job in their field after graduation appear in Table 6. Overall, self-rating of undergraduate preparation was the most significant positive predictor. Students who felt very well prepared for their graduate studies had 2.5 times greater odds of expecting to find a field-related job. Anticipation of positive faculty/student interactions was associated with increased employment expectations, with each point increase on this scale accounting for a 6% increase in the anticipated odds of finding a job. Students enrolled in engineering had 2.6 times higher odds of expecting to find a job in their field than physical

BEST COPY AVAILABLE

sciences students.

Perception of race as an admissions liability had the strongest negative association with expected post-graduate employment. In our sample, minority and Anglo males who felt racially-disadvantaged in terms of program admission had 75% lower odds of expecting to find related employment. This continues a pattern of perceived disadvantage noted earlier in relation to expected earnings. Foreign students had 56% lower odds of expecting employment within their field of study. Students whose fathers are scientists or engineers were more pessimistic about finding a related job, with 50% lower odds in this regard than peers whose fathers are employed in other fields. Similar to the negative association between maternal science/engineering employment on student salary expectations, this may reflect their greater awareness of a competitive job market. Finally, two institutional factors--funding concerns and membership in a research group--each reduced the odds of student employment expectations by approximately 50%. As was anticipated, students who are concerned about financing their graduate education may be unsure about program completion, and may not have the resources to permit an extended job search. However, the negative contribution of research group membership runs counter to our expectations. It may be that this involvement, which presumably permits close exposure to faculty efforts at grantsmanship and research, sensitizes students' to the difficulty of attracting funding to support one's work.

-- Table 7 about here --

Expectations of limited career advancement opportunities.

For students who felt their race to be an admissions liability, the odds were four time greater that they expected to have limited opportunities for career advancement. While only significant at $p < .1$, this is still consistent with our previous findings about student perceptions of racial discrimination and reduced earnings and employment expectations. Compared to Anglo students, foreign students had 3 times higher odds of expecting restricted career movement. This also reinforces our prior results. And again, funding concerns and research group membership were predictive of students' being less optimistic about their professional future. Students who were worried about

funding had almost 5 times greater odds of expecting career advancement restrictions. Those who were a member of a research group at the time of survey completion had 3 times greater odds of expecting limited upward career movement. As with the model for finding a job, we presume that financially insecure students may be less sure about completing or doing well in their graduate program; this may subsequently translate into limited career expectations. As suggested before, students involved in research groups may be exposed to more information about the difficulties of achieving professional success than students who do not have such sustained proximity to research activities.

Conversely, students who were enrolled in an engineering program, were employed during the 1995-96 academic year, or whose mother was employed were less likely to expect limitations on their career advancement. Engineering students had 5 times lower odds of anticipating problems with career advancement. Presumably this reflects optimistic employment projections in engineering fields. Students who were currently employed and those whose mothers were employed outside the home had 56% and 50% lower odds, respectively, of expecting career advancement limitations. In the former instance, employed students may expect their work experience to increase their competitive advantage and upward mobility in terms of employment. In the latter case, a role modeling effect may be in operation.

-- Table 8 about here --

Expectations of experiencing family/work conflicts.

Only three variables proved to be significant in the full model predicting student expectations of experiencing family/work conflicts. Of these, marital status was the strongest predictor. For students who are married or cohabiting, the odds that they anticipated conflict between their family and career obligations were almost four times greater compared to single students. This is in keeping with the conceptual literature (Girves & Wemmerus, 1988; Tinto, 1993). However, contrary to our expectations and results of prior research (Jackson et al., 1993; Smith, 1994; Zappert & Stansbury, 1984), gender was not predictive of students' concerns in this regard.

Two aspects of students' undergraduate preparation reduced the likelihood of their concern about family/work conflicts. Students who felt well prepared for graduate studies had 60% lower odds of anticipating these conflicts, while for students with master's degrees, the odds were 80% lower compared to students entering their graduate program with a baccalaureate degree. It follows that students who feel more adequately prepared academically, or those who have already completed some graduate training may feel less concerned about their future ability to juggle personal and professional roles.

Summary and Conclusions

With the intent of extending research conducted primarily at the undergraduate level, the current study explored gender and ethnic differences in academic self-confidence, academic self-efficacy, and career-related outcome expectations of graduate science and engineering students at point of program entry. Further, we tested the capacity of demographic characteristics, background characteristics, prior academic preparation, expectations and institutional factors to predict outcome measures. For the most part, there were few gender or ethnic differences evident in student demographic characteristics, social origins, academic credentials and institutional profiles. While significant gender differences were found in GRE quantitative scores, this should be qualified by the observation that, on average, both genders were performing above the 80th percentile. Our finding that women and minority students entered their graduate programs with generally equivalent records of academic achievement concurs with prior research (Felder et al., 1995; Zappert & Stansbury, 1984). Further, this suggests that subsequent differences in academic performance and persistence across status groups are more likely to be the result of social cognitive or institutional variables than academic predictors (Hornig, 1987; Zwick, 1991).

Our multivariate results suggest that demographic characteristics play a significant, albeit sometimes unexpected, role in the prediction of several outcome measures. Despite relative equivalence in prior academic and work experiences, women in our study reported less confidence in their academic abilities than men, a result in keeping with our expectations and previous research

(Felder et al., 1995; Hurtado, 1994; Jackson et al., 1993). On the one hand, this suggests that even at this level of educational accomplishment (that is, securing admission to a highly selective graduate program), women have somehow failed to internalize positive beliefs about their academic abilities. Socialization messages about the unsuitability of science and engineering careers for women (Morgan, 1992; Brush, 1991) and teaching methods that foster competitive learning environments (Tobias, 1990) are among theories proposed to explain this lack of confidence. Gilligan (1982) and Tannen (1990) suggest that women may learn to underreport their abilities as a result of socialization experiences that teach females to value affiliation over competitiveness. If so, it is possible that these apparent gender differences are an artifact of using academic self-confidence measures that require women to rate their academic abilities relative to those of their peers.

Gender was only marginally predictive of academic self-efficacy and was not a significant factor in predicting career-related outcome expectations. This suggests that at least at point of program entry, women are as optimistic as males in their expectations of finding a job, annual salary, career advancement opportunities, and experiencing family/work conflict. The absence of gender differences in outcome expectations runs counter to previous undergraduate research (Hackett et al., 1992; Jackson et al., 1993). Perhaps at this level of academic credentials, most students presume that status issues will not affect career consequences. Unfortunately, statistics on gender and ethnic differences in earnings, representation in high level positions, and unemployment in science and engineering fields do not support this optimism (National Science Foundation, 1994; Vetter, 1996).

U.S. minority students reported significantly higher academic self-efficacy than Anglo students, despite having lower GRE scores and self-ratings of the adequacy of their undergraduate preparation. It may be that for minority students, having successfully beaten the odds by gaining admission to an academically selective, Anglo-dominated graduate program is sufficient proof of their ability to complete degree requirements (Hurtado, 1994). Research also suggests that minority students may use cognitive strategies to bolster their sense of competence in the face of external threats (Nettles, 1990; Sedlacek, 1987). Having strong self-efficacy expectations may be one example of such

strategies. International students were less optimistic than Anglo students in their expectations of securing field-related employment, annual earnings, and career advancement. We believe this to be indicative of comparatively restricted employment opportunities both within the U.S. and their restricted countries of origin.

Marital status was predictive of higher academic self-efficacy, expected annual earnings, and expectations of experiencing family/work conflicts. The positive association between marital status and academic self-efficacy conflicts with the conceptual literature on graduate student persistence (Girves & Wemmerus, 1988; Tinto, 1993). It seems that, at the onset of graduate studies, married and cohabiting students expect their intimate relationships to provide needed emotional support.

Finally, students who were going to be employed on- or off-campus during the 1995-96 academic year had higher academic self-efficacy and anticipated fewer limitations on career advancement than their unemployed peers. Earlier analyses using separate variables for research assistantships, teaching assistantships, other on-campus employment, and off-campus employment did not emerge as significant predictors. Although seemingly contrary to a growing body of literature that suggests it is the form of funding that matters as well as the amount (Tinto, 1993; Widnall, 1988), for our entering students, it was the fact of employment versus unemployment that proved to be significant. We speculate that this may be due to the departmental incorporation implied by on-campus employment, or to the opportunity for skill development thus provided. However, we recognize that the differential influence of various forms of student employment may not become evident until later points in the graduate experience, particularly as students move beyond coursework expectations.

Student background characteristics produced mixed effects in the models. Their influence was relatively weak, with variables in this block only entering in at the $p<.10$ level of significance. Students from upper-class socioeconomic backgrounds reported higher academic self-efficacy than their middle-class counterparts. Those students whose mothers were employed outside the home expected fewer limitations on career advancement. These results are consistent with our expectations

and with undergraduate research (Jagacinski et al., 1987; Hurtado, 1994). However, students whose mothers were college educated were more likely to report lower academic self-efficacy; maternal employment as a scientist or engineer was predictive of lower expectations for annual earnings; and paternal employment as a scientist or engineer predicted lower expectations of finding a field-related job. These findings conflict with related undergraduate research (Astin & Sax, 1994; Jagacinski et al., 1987; Peng & Jaffee, 1979). We think these relationships may reflect students' realistic appraisals of the rigors of graduate school and the professional arena, as garnered through the experiences of their parents.

As anticipated, students' prior academic achievements emerged as predictors of several outcome measures. Most notably, students who felt adequately prepared by their undergraduate program reported higher academic self-confidence and academic self-efficacy, more optimistic expectations about obtaining a field-related job, and less anticipation of family/work conflicts. By comparison, undergraduate grade point average was only a significant predictor of academic self-confidence. As social cognitive theory would suggest, it appears that students' perceptions of their academic preparedness figure more prominently in their academic and occupational expectations than do objective measures of academic ability. No doubt, the predictive capacity of undergraduate grade point average was mitigated by the uniformly high grade achievement of this cohort. Students entering with a master's degree expected less family/work conflict than students without a graduate degree. In the former case, we presume this derives from their prior experience with balancing academic and nonacademic demands.

Consistent with the graduate literature (Berg & Ferber, 1983; Hurtado & Carter, 1994; Tinto, 1993), students who expected positive interactions with program faculty were also more positive about their ability to complete degree requirements, as evidenced by higher academic self-efficacy ratings. Similarly, having positive expectations about faculty predicted greater anticipation of finding a job and earning a higher annual salary upon degree completion. Of course, these are only students' expectations of faculty interactions at point of program entry; whether these expectations will be borne

out remains to be seen. Nevertheless, these results underscore the important role of faculty/student interactions in shaping students' views of their probable academic and professional success.

Perhaps most surprising to us were the differences across groups in the perception of gender and race as admission liabilities or assets and further, the extent to which beliefs of gender and race as liabilities predicted outcome measures. Students who perceived their racial status as a detriment to admission were also more likely to report lower academic self-efficacy, to anticipate less likelihood of finding a job, and greater likelihood of experiencing limitations in career advancement. Conversely, they expected higher annual earnings than students who did not feel racially disadvantaged. Students who perceived of their gender as an admissions liability expected lower annual earnings after degree completion. We know, both from descriptive statistics and from narrative comments included in the survey instrument, that these perceptions of comparative disadvantage emanate primarily from Anglo males. We must emphasize that these views pertain to a small proportion of males within the sample. However, given the importance of peer relationships in determining the quality of the graduate academic environment (Hurtado & Carter, 1994; Stage & Maple, 1993), these findings warrant further investigation.

Several institutional factors also predicted outcome measures. Compared to students in the physical sciences, engineering students reported higher academic self-efficacy and were more likely to expect to find a field-related job, to earn a higher annual salary, and experience fewer limitations on career advancement. Predictably, doctoral students expected higher annual earnings after degree completion than master's degree students. Students who were concerned about funding reported lower academic self-efficacy, less likelihood of finding a field-related job, and greater chances of limited career advancement. This reinforces the importance of funding as an influence on student persistence, as has been suggested in the literature (Girves & Wemmerus, 1988; Tinto, 1993). It is interesting to note that students who were already involved in a research group within their department were less likely to expect to find a field-related job and anticipated more limitations to their career advancement, while students who had a faculty mentor expected lower annual earnings after degree completion. On

the surface, these results run counter to assumptions about the importance of mentoring and research involvement as vehicles to promote student socialization within disciplinary norms (Girves & Wemmerus, 1988; Hollenshead et al., 1996; Widnall, 1988). While we suspect that these reduced expectations may result in part from students' increased exposure to the rigors and competitiveness of academic and professional life, other factors such as departmental differences in the organization of research groups may be involved. Further information is needed to clarify operative influences.

Overall, our findings support previous evidence that women students in graduate science and engineering have lower academic self-confidence than their male counterparts. However, the influence of gender was less pronounced in relation to academic self-efficacy and did not enter into models predicting career-related outcome expectations. Racial/ethnic status among U.S. minority students was predictive of higher academic self-efficacy. Foreign student status was associated with reduced career-related outcome expectations.While predictors of outcome measures were found across all blocks of entering characteristics, background characteristics indicative of parental socioeconomic status were less influential than has been demonstrated at the undergraduate level (Hurtado, 1994.) We are struck by the extent to which student perceptions of academic preparedness, status-related disadvantages, and expectations of faculty/student interactions emerged as predictors of academic self-efficacy and career-related outcome expectations. This suggests to us that institutions must be mindful of the academic climate that is fostered, intentionally and unintentionally, within departments. In addition, several variables under institutional control--student funding, faculty mentors, research group opportunities, and student employment--contributed to outcome measures, although not always in expected ways.

Some limitations of our study must be noted. The measurement of academic self-efficacy utilized in our study represents an improvement over the previous work of Zappert and Stansbury (1984). To the extent that it requires students to rate confidence in completing program requirements, it is consistent with the intent of academic milestones scales employed in previous research (Brown et al., 1989; Lent et al., 1986). However, scale items may be too general to adequately tap efficacy

expectations. Further, we have not tested the psychometric properties of this scale. We plan to strengthen the measurement of this construct for use in future research with this cohort.

The fact that our results are based upon science and engineering students enrolled in a single, highly selective institution necessarily limits the extent to which findings can be generalized to first year science and engineering students in other institutions, or to the graduate student population in general. Nevertheless, we think this project stands to contribute important insights to a relatively neglected aspect of the science and engineering pipeline, and may offer a useful framework for extending similar research to other institutional settings.

At this point, we have provided a snapshot of student perceptions and expectations taken at point of program entry. Will these findings persist? The extant literature leads us to expect considerable change in these variables as students move through their graduate programs, most likely in directions contrary to the relative optimism expressed by entering women and minority students. Over the next five years, administrative data will be collected and follow-up surveys administered to track the performance, perceptions, and expectations of this cohort. In addition, qualitative data derived from focus groups and individual interviews with students, faculty and staff will be used to enrich our understanding of factors and dynamics shaping these students' graduate experiences.

References

Adams, H. G. (1993). Focusing on the campus milieu: A guide for enhancing the graduate school climate. National Consortium for Graduate Degrees for Minorities in Engineering and Science, Inc. (GEM).

Adams, H. G. (1988). Advanced degrees for minority students in engineering. Engineering Education, 78, 775-777.

Alper, J. (1993). The pipeline is leaking women all the way along. Science, 260, 409-411.

Astin, A. W. (1993). What matters in college? "Four critical years" revisited. San Francisco: Jossey-Bass.

Astin, A. W., & Astin, H. S. (1992). Undergraduate science education: The impact of different college environments on the educational pipeline in the sciences. Los Angeles: Higher Education Research Institute, University of California.

Astin, H. S., & Sax, L. J. (1994). Undergraduate women in science: Personal and environmental influences on the development of scientific talent. Los Angeles, CA: Higher Education Research Institute, University of California.

Bandura, A. (1986). Social foundations of thought and action: A social cognitive theory. Englewood Cliffs, NJ: Prentice Hall.

Bandura, A. (1982). Self-efficacy mechanism in human agency. American Psychologist, 37, (2), 122-147.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. Psychological Review, 84, (2), 191-215.

Barber, L. A. (1995). U.S. women in science and engineering, 1960-1990. Journal of Higher Education, 66, (2), 213-234.

Berg, H. M., & Ferber, M. A. (1983). Men and women graduate students: Who succeeds and why? Journal of Higher Education, 54, (6), 629-648.

Bowen, W. B., & Rudenstine, N. L. (1992). In pursuit of the PhD. Princeton, NJ: Princeton University Press.

Brown, S. D., Lent, R. W., & Larkin, K. C. (1989). Self-efficacy as a moderator of scholastic aptitude-academic performance relationships. Journal of Vocational Behavior, 35, 64-75.

Brush, S. G. (1991). Women in science and engineering. American Scientist, 79, 404-419.

Clewell, B. C., & Ginorio, A. B. (1996). Examining women's progress in the sciences from the perspective of diversity. In C. S. Davis, A. B. Ginorio, C. S. Hollenshead, B. B. Lazarus, P. M. Rayman, & Associates (Eds.), The Equity Equation: Fostering the advancement of women in the sciences, mathematics, and engineering. (pp. 163-231). San Francisco: Jossey-Bass.

Davis, C. S., Ginorio, A. B., Hollenshead, C. S., Lazarus, B. B., Rayman, P. M. & Associates. (Eds.) (1996). The equity equation: Fostering the advancement of women in the sciences, mathematics, and engineering. San Francisco: Jossey-Bass.

Estes, W. K. (1972). Reinforcement in human behavior. American Scientist, 60, 723-729.

Etzkowitz, H., Kemelgor, C., Neuschatz, M., & Uzzi, B. (1992). Athena unbound: Barriers to women in academic science and engineering. Science and Public Policy, 19, (3), 157-179.

Felder, R. M., Felder, G. N., Mauney, M., Hamrin, C. E., & Dietz, E. J. (1995). A longitudinal study of engineering student performance and retention. III. Gender differences in student performance and attitudes. Journal of Engineering Education, 84, (2), 151-163.

Frieze, I. H., & Hanusa, B. H. (1984). Women scientists: Overcoming barriers. Advancements in Motivation and Achievement, 2, 139-136.

Gilligan, C. (1982). In a different voice: Psychological theory and women's development. Cambridge, MA: Harvard University Press.

Girves, J. E., & Wemmerus, V. (1988). Developing models of graduate student degree progress. Journal of Higher Education, 59, (2), 163-189.

Hackett, G., Betz, N. E., Casas, J. M., & Rocha-Singh, I. A. (1992). Gender, ethnicity, and social cognitive factors predicting the academic achievement of students in engineering. Journal of Counseling Psychology, 39, (4), 527-538.

Hollenshead, C. S., Wenzel, S. A., Lazarus, B. B., & Nair, I. (1996). The graduate experience in the sciences and engineering: Rethinking a gendered institution. In C. S. Davis, A. B. Ginorio, C. S. Hollenshead, B. B. Lazarus, P. M. Rayman, & Associates (Eds.), The equity equation: Fostering the advancement of women in the sciences, mathematics, and engineering (pp. 122-162). San Francisco: Jossey-Bass.

Hornig, L. S. (1987). Women graduate students: A literature review and synthesis. In L.S. Dix (Ed.), Women: Their underrepresentation and career differentials in science and engineering. Proceedings of a workshop. Washington, DC: National Academy Press.

House, J. D. (1993). The relationship between academic self-concept and school withdrawal. The Journal of Social Psychology, 133, (1), 125-127.

House, J. D. (1992). The relationship between academic self-concept, achievement-related expectancies, and college attrition. Journal of College Student Development, 33, 5-10.

Hurtado, S. (1994). Graduate school racial climates and academic self-concept among minority graduate students in the 1970s. American Journal of Education, 102, (3), 330-351.

Hurtado, S., & Carter, D. G. (1994). Environmental influences on students expectations for doctoral degree progress. Paper presented at the annual conference of the Association for the Study of Higher Education, Tucson, AZ.

Isaac, P. D., Malaney, G. D., & Karras, J. E. (1992). Parental educational level, gender differences, and seniors' aspirations for advanced study. Research in Higher Education, 33, (5), 595-606.

Jackson, L. A., Gardner, P. D., & Sullivan, L. A. (1993). Engineering persistence: Past, present, and future factors and gender differences. Higher Education, 26, (2), 227-246.

Jagacinski, C. M., & LeBold, W. K. (1981). A comparison of men and women undergraduates and professional engineers. Engineering Education, 72, (3), 213-220.

Jagacinski, C. M., LeBold, W. K., & Linden, K. W. (1987). The relative career advancement of men and women in the United States. Work and Stress, 1, (3), 235-247.

Lent, R. W., Brown, S. D., & Larkin, K. C. (1986). Self-efficacy in the prediction of academic performance and perceived career options. Journal of Counseling Psychology, 33, (3), 265-269.

Lomperis, A. M. T. (1990). Are women changing the nature of the academic profession? Journal of Higher Education, 61, 644-666.

Maccoby, E. E., & Jacklin, C. N. (1974). The psychology of sex differences. Stanford, CA: Stanford University Press.

Malaney, G. D. (1988). Graduate education as an area of research in the field of higher education. In J. C. Smart (Ed.), Higher education: Handbook of theory and research. (Vol. IV). New York: Agathon Press, Inc.

Malcom, S. (1989). Increasing the participation of black women in science and technology. SAGE, 6, (2), 15-17.

Malcom, S. M., Hall, P. Q., & Brown, J. W. (1976). The double bind: The price of being a minority woman in science. (AAAS Report No. 76-R-#). Washington, DC: American Association for the Advancement of Science.

Mellow, G. O., & Goldsmith, D. (1988). Small indignities, large affronts: A qualitative study of graduate life. Paper written for The Status of Women at the University of Connecticut, The Women's Center.

Mooney, J. D. (1969). Attrition among Ph.D. candidates: An analysis of a cohort of recent Woodrow Wilson fellows. Journal of Human Resources, 3, 47-62.

Morgan, C. S. (1992). College students' perceptions of barriers to women in science and engineering. Youth & Society, 24, (2), 228-236.

National Science Foundation. (1995). Selected data on science and engineering doctorate awards: 1994. (NSF Report No. 95-337). Arlington, VA: Author.

National Science Foundation. (1994). Women, minorities, and persons with disabilities in science and engineering. (NSF Report No. 94-333). Arlington, VA: Author.

Nerad, M., & Stewart, C. L. (1991). Assessing doctoral student experience: Gender and departmental climate. Paper presented at the annual conference of the Association for Institutional Research, San Francisco, CA.

Nettles, M. T. (1990). Success in doctoral programs: Experiences of minority and White students. American Journal of Education, 98, 494-522.

Ott, M. D. (1978). Experiences, aspirations and attitudes of male and female freshmen. Engineering Education, 68, (4), 326-333, 338.

Owen, S. V., & Froman, R. B. (1988). Development of a college academic self-efficacy scale. Paper presented at the annual meeting of the National Council on Measurement in Education, New Orleans, LA.

Pajares, F. (1996). Assessing self-efficacy beliefs and academic outcomes: The case for specificity and correspondence. Paper presented at the 1996 Annual Meetings of the American Educational Research Association, New York, NY.

Pajares, F., & Miller, M. D. (1994). Role of self-efficacy and self-concept beliefs in mathematical problem solving: A path analysis. Journal of Educational Psychology, 86, (2), 193-203.

Pascarella, E. T., Smart, J. C., Ethington, C., & Nettles, M. (1987). The influence of college on self-concept: A consideration of race and gender differences. American Educational Research Journal, 24, (1), 49-77.

Peng, S., & Jaffe, J. (1979). Women who enter male-dominated fields of study in higher education. American Educational Research Journal, 16, 285-293.

Santiago, A. M., & Einarson, M. K. (1996). The graduate experience in engineering and the physical sciences: Gender and ethnic differences in initial expectations and departmental incorporation. Paper presented at the 1996 Annual Meetings of the American Educational Research Association, New York, NY.

Sax, L. J. (1994). Mathematical self-concept: How college reinforces the gender gap. Research in Higher Education, 35, (2), 141-166.

Schroeder, D. S., & Mynatt, C. R. (1993). Female graduate students' perceptions of their interactions with male and female major professors. Journal of Higher Education, 64, 555-573.

Sedlacek, W. E. (1987). Black students on White campuses: .20 years of research. Journal of College Student Personnel, 28, 484-95.

Seymour, E., & Hewitt, N. (1994). Talking about leaving: Factors contributing to high attrition rates among science, mathematics, and engineering undergraduate majors. Final report to the Alfred P. Sloan Foundation, University of Colorado, Boulder.

Shavelson, R. J., & Bolus, R. (1982). Self-concept: The interplay of theory and methods. Journal of Educational Psychology, 74, 3-17.

Shavelson, R., Hubner, J., & Stanton, G. (1976). Self-concept: Validation of construct interpretations. Review of Educational Research, 46, 407-441.

Sotello Viernes Turner, C., & Thompson, J. R. (1993). Socializing women doctoral students: Minority and majority experiences. Review of Higher Education, 16, (3), 355-370.

Stage, F. K., & Maple, S. (1993, November). Dropping out of the mathematics/science pipeline: Narratives of women doctoral candidates. Paper presented at the annual meeting of the Association for the Study of Higher Education, Pittsburgh, PA.

Syverson, P. D. (1982). Doctorate recipients from United States universities: Summary report 1981. Washington, DC: National Academy Press.

Syverson, P. D., & Forster, L. E. (1983). Doctorate recipients from United States universities: Summary report 1983. Washington, DC: National Academy Press.

Tannen, D. (1990). You just don't understand: Women and men in conversation. (1st ed.). New York: Morrow.

Tinto, V. (1993). Leaving college: Rethinking the causes and cures of student attrition. (2nd ed.). Chicago: University of Chicago Press.

Tobias, S. (1990). They're not dumb, they're different: Stalking the second tier. Tucson, AZ: Research Corporation.

Vetter, B. M. (1996). Myths and realities of women's progress in the sciences, mathematics, and engineering. In C. S. Davis, A. B. Ginorio, C. S. Hollenshead, B. B. Lazarus, P. M. Rayman, & Associates (Eds.), The equity equation: Fostering the advancement of women in the sciences, mathematics, and engineering. (pp. 29-56). San Francisco: Jossey-Bass.

Widnall, S. E. (1988). AAAS presidential lecture: Voices from the pipeline. Science, 241, 1740-1745.

Zappert, L. T., & Stansbury, K. I. (1984). In the pipeline: A comparative analysis of men and women in graduate programs in science, engineering and medicine at Stanford University. (Paper No. 20). Stanford, CA: Stanford University, Institute for Research on Women and Gender.

Zwick, R. (1991). Differences in graduate school attainment patterns across academic programs and demographic groups. (Research Rep. No. 143). Princeton, NJ: Educational Testing Service.

Table 1 Entering Characteristics of First Year Engineering and Physical Sciences Graduate Student Sample by Gender, Ethnicity, and Resident Status

	All Men	Anglo Men	Minority Men	Foreign Men	All Women	Anglo Women	Minority Women	Foreign Women
	X or %	X or %	X or %	X or %	X or %	X or %	X or %	X or %
Demographic Characteristics								
Marital status	11.5	24.6	25.0	23.2	18.3	40.0	8.3	13.0
Employment status in 1995-96	51.8	61.8	45.8	39.0	45.1	48.6	33.3	43.5
Background Characteristics								
Mother has college degree	52.7	50.0	62.5	55.0	66.2	71.5	75.0	52.1
Father has college degree	66.9	68.2	58.3	69.6	71.8	68.5	66.6	78.2
Mother is scientist/engineer	5.5	1.8	8.4	9.8	11.3	5.7	16.7	17.3
Father is scientist/engineer	21.6	25.7	29.1	17.0	25.4	20.0	25.0	34.8
Lower/working class status	21.1	22.7	25.0	17.1	18.3	17.1	16.7	21.7
Upper class status	10.6	10.0	4.2	13.4	18.3	5.7	33.3	26.1
Mother is employed	72.5	79.1	70.8	64.6	74.7	80.0	83.3	60.9
Undergraduate/Post BA Preparation								
Undergraduate GPA (4.0 scale)	3.5	3.5	3.5	3.4	3.5	3.5	3.4	3.5
GRE Verbal Score	563.4	604.2*	525.5	525.7*	543.7	599.3*	497.1	478.3*
GRE Math Score	754.8*	750.1	736.0*	765.7*	719.9*	720.6*	690.0	730.6
GRE Analytical Score	689.1	714.5	670.5	663.2	669.6	707.0	632.9	625.6
Self rating of undergraduate preparation	41.7	42.7	29.2	45.1	32.4	34.3	41.7	26.1
Holds MA degree	13.8	10.9	4.2	20.7	11.3	2.9	8.3	26.1
Post BA work experience	56.0	60.0	45.8	53.7	62.0	34.3	66.7	60.9
Student Expectations								
Student expectations re: faculty/student interactions	112.7	111.6	115.2	113.4	113.6	113.6	112.8	113.8
Student perception of gender as an asset	1.8*	0.0*	4.2*	2.4	40.9*	60.0*	50.0*	8.7
Student perception of gender as a liability	8.3*	11.8*	12.5*	2.4	0.0*	0.0*	0.0*	0.0
Student perception of race as an asset	2.8	.9	17.4	1.2	5.6	0.0	33.3	0.0
Student perception of race as a liability	10.6*	11.8*	21.7*	6.1	0.0*	0.0*	0.0*	0.0
Institutional Factors								
Enrolled for Doctoral Degree	35.3	37.3	20.8	37.8	29.6	28.6	16.3	39.1
Enrolled in Engineering Program	87.1	88.2	87.5	85.4	80.3	77.1	100.0	73.9
Has mentor in 1995-96	8.7	12.7	4.2	4.9	11.3	8.6	25.0	8.7
Belongs to research group	31.7	34.5	16.7	31.7	28.2	22.9	25.0	34.8
Has graduate assistantship	38.1	46.4	16.7	34.2	38.0	37.1	25.0	43.5
Has graduate fellowship	29.4	30.0	50.0	22.0	39.4	42.9	58.3	26.1
Has funding concerns	57.3	48.2	62.5	67.1	56.3	62.9	41.7	56.5
n of cases	218	110	24	82	71	35	12	24

SOURCE: Derived by the authors using Fall 1995 Graduate Experience Project data. * Differences across groups are significant at the $p < .05$ level, Scheffe test, one way ANOVA or t test for gender differences.

Table 2. Academic Self-Confidence, Academic Self-Efficacy, and Outcome Expectations of First-Year Engineering and Physical Sciences Graduate Students by Gender, Ethnicity, and Resident Status

	All Men	Anglo Men	Minority Men	Foreign Men	All Women	Anglo Women	Minority Women	Foreign Women
	X or %	X or %	X or %	X or %	X or %	X or %	X or %	X or %
Academic Self-Confidence/Self-Efficacy Measures								
Academic self-confidence	41.8*	41.8	41.4	42.0	38.7*	38.9	42.9	36.2
Academic self-efficacy	15.3	15.0	15.8	15.4	14.8	15.0	16.6	13.3
Outcome Expectations								
Expected annual salary upon completion of degree ($)	47252	50074	47227	43197	44373	45645	50000	37688
Expect to experience family/work conflicts	22.4	25.2	29.2	17.1	28.9	37.1	16.7	23.8
Expect to have limited opportunities for career advancement	23.0	10.4*	25.0	39.0*	18.8	14.3	16.7	28.6
Expect to find a job in field of study	58.7	62.7	66.7	50.0	59.2	68.6	75.0	34.8
n of cases	218	110	24	82	71	35	12	24

SOURCE: Derived by the authors using Fall 1995 Graduate Experience Project data. * Differences across groups are significant at the $p < .05$ level, Scheffe test, one-way ANOVA or t-test for gender differences.

Table 3. Hierarchical OLS Regression Models Predicting Student Ratings of Academic Self-Confidence

	Model 1 (n = 267)		Model 2 (n = 267)		Model 3 (n = 253)		Model 4 (n = 249)		Model 5 (n = 249)	
	B	S.E.	B	S.E.	B	S.E.	B	S.E.	B	S.E.
Demographic Characteristics										
Gender of R	-2.996***	1.106	-3.533***	1.093	-3.556***	1.082	-3.798***	1.124	-3.420***	1.132
Minority status	1.557	1.489	1.156	1.476	1.896	1.420	1.774	1.491	1.833	1.492
Foreign status	.508	1.040	.152	1.051	.254	1.074	.300	1.104	.546	1.142
Marital status	1.835*	1.097	1.883*	1.086	1.453	1.074	1.348	1.108	1.227	1.107
Employment status in 1995-96	3.039***	.956	3.434***	.962	2.756***	.946	2.773***	.967	3.004***	1.102
Background Characteristics										
Mother has college degree			1.067	1.116	.842	1.097	.921	1.125	.810	1.124
Father has college degree			.904	1.287	.444	1.263	.211	1.327	.592	1.344
Mother is scientist/engineer			3.574*	2.056	2.819	2.108	3.007	2.188	2.534	2.187
Father is scientist/engineer			1.824	1.228	.694	1.211	.776	1.249	.327	1.272
Lower/working class status			-.236	1.360	-.966	1.330	-1.021	1.361	-.674	1.365
Upper class status			2.330	1.468	1.617	1.446	1.723	1.495	1.128	1.512
Mother is employed			.879	1.121	.608	1.097	.550	1.113	.593	1.116
Undergraduate/Post BA Preparation										
Undergraduate GPA (4.0 scale)					4.616***	1.531	4.561***	1.572	4.386***	1.581
Self-rating of undergraduate preparation					4.182***	.945	3.948***	.970	3.606***	.989
Holds MA degree					1.371	1.385	1.159	1.443	.684	1.640
Post-BA work experience					1.031	.836	.968	.865	1.191	.876
Student Expectations										
Student expectations re: faculty/student interactions							-.011	.075	-.017	.076
Student perception of gender as liability							2.575	2.728	1.935	2.726
Student perception of race as liability							-2.820	2.505	-2.175	2.504
Institutional Factors										
Type of degree									.274	.672
Program									2.762*	1.645
Has mentor in 1995-96									-2.472	1.585
Belongs to research group									1.145	1.101
R has funding concerns									-.855	1.004
Intercept	39.399***		36.769***		19.700***		21.526**		19.736*	
Adjusted R^2	.054		.096		.180		.163		.174	
F	4.163***		3.482***		4.599***		3.639***		3.256***	

SOURCE: Derived by authors from Fall 1995 Graduate Experience Project data. *** p < .01, ** p < .05, * p < .10.

Table 4. Hierarchical OLS Regression Models Predicting Student Ratings of Academic Self-Efficacy

	Model 1 (n = 267)		Model 2 (n = 267)		Model 3 (n = 253)		Model 4 (n = 249)		Model 5 (n = 249)	
	B	S.E.	B	S.E.	B	S.E.	B	S.E.	B	S.E.
Demographic Characteristics										
Gender of R	.488	.523	-.596	.521	-.411	.516	-.810	.513	-.916*	.499
Minority status	1.501**	.703	1.525**	.702	1.674**	.673	1.780***	.675	1.733***	.653
Foreign status	.203	.494	.041	.505	-.140	.518	-.518	.509	-.074	.510
Marital status	1.169**	.521	1.258**	.520	1.173**	.516	1.013**	.507	.928*	.491
Employment status in 1995-96	.215	.455	.223	.461	-.116	.452	-.279	.441	-.254	.446
Background Characteristics										
Mother has college degree			-.912*	.531	-1.065**	.520	-.977*	.511	-.957*	.494
Father has college degree			1.047*	.610	.955	.599	.670	.603	.460	.592
Mother is scientist/engineer			.993	.967	.691	.993	.356	.984	.569	.952
Father is scientist/engineer			-1.102*	.584	1.136*	.578	-1.168**	.566	-.858	.558
Lower/working class status			.298	.647	.234	.630	.051	.617	.154	.560
Upper class status			1.550**	.721	1.470**	.716	1.292*	.708	1.162*	.695
Mother is employed			.838	.537	.625	.524	.621	.508	.584	.493
Undergraduate/Post BA Preparation										
Undergraduate GPA (4.0 scale)					-.442	.741	-.736	.724	-.861	.703
Self rating of undergraduate preparation					2.219***	.452	2.242***	.443	1.820***	.437
Holds MA degree					.667	.653	1.000	.651	1.161	.730
Post-BA work experience					.717*	.401	-.635	.396	-.292	.390
Student Expectations										
Student expectations re: faculty/student interactions							.097***	.034	.099***	.034
Student perception of gender as liability							1.168	1.226	.935	1.188
Student perception of race as liability							-3.411***	1.126	-3.373***	1.091
Institutional Factors										
Type of degree									-.233	.307
Program									-.297	.733
Has mentor in 1995-96									.530	.700
Belongs to research group									.157	.491
R has funding concerns									-1.978***	.447
Intercept	14.521***		13.698***		15.287***		6.088		8.037*	
Adjusted R^2	.018		.047		.131		.199		.258	
F	1.962*		2.098**		3.379***		4.241***		4.596***	

SOURCE: Derived by authors from Fall 1995 Graduate Experience Project data. *** p < .01, ** p < .05, * p < .10.

BEST COPY AVAILABLE

Table 5. Hierarchical OLS Regression Models Predicting Expected Annual Earnings on Completion of Graduate Training

	Model 1 (n = 261)		Model 2 (n = 261)		Model 3 (n = 250)		Model 4 (n = 246)		Model 5 (n = 246)	
	B	S.E.	B	S.E.	B	S.E.	B	S.E.	B	S.E.
Demographic Characteristics										
Gender of R	-2682.0	2216.0	-3324.0	2240.0	-3908.0*	2221.0	-4171.0*	2252.3	-3272.0	2245.0
Minority status	741.0	2790.0	-292.0	2832.0	929.0	2793.0	-708.0	2866.3	-406.0	2842.0
Foreign status	-6542.0***	2048.0	-6525.0***	2107.0	-6454.0***	2155.0	-7363.0***	2159.0	-6592.0***	2205.0
Marital status	2805.0	2101.0	3786.0*	2119.0	3395.0	2137.0	4414.0**	2155.0	3965.0*	2137.0
Employment status in 1995 96	2153.0	1850.0	2576.0	1894.0	2274.0	1890.0	2439.0	1899.0	3171.0	1966.0
Background Characteristics										
Mother has college degree			444.0	2208.0	696.0	2195.0	-1527.0	2202.0	-1621.0	2194.0
Father has college degree			2214.0	2621.0	3101.0	2594.0	3006.0	2600.0	3797.0	2607.0
Mother is scientist/engineer			-5171.0	4042.0	-7016.0*	4230.1	-8026.0*	4211.0	-7315.0*	4171.0
Father is scientist/engineer			-206.0	2488.0	-1256.0	2510.0	-1144.0	2518.0	-2250.0	2534.0
Lower/working class status			-1774.0	2679.0	-2641.0	2647.0	-2708.0	2654.0	-1885.0	2645.0
Upper class status			5379.0*	2868.0	4677.0	2882.0	4941.0*	2866.0	4115.0	2870.0
Mother is employed			283.0	2227.0	1468.0	2198.0	1030.0	2182.0	910.0	2172.0
Undergraduate/Post BA Preparation										
Undergraduate GPA (4.0 scale)					2853.0	3031.1	2858.0	3043.0	2344.0	3039.0
Self rating of undergraduate preparation					1175.0	1882.0	1128.0	1889.0	750.0	1914.0
Holds MA degree					4105.0	2749.0	3121.0	2793.0	622.0	3142.0
Post BA work experience					1145.0	1693.0	1164.0	1692.0	1551.0	1690.0
Student Expectations										
Student expectations re: faculty/student interactions							399.0***	147.0	401.0***	148.0
Student perception of gender as liability							-8628.0*	5112.0	-10351.0**	5076.0
Student perception of race as liability							9083.0**	4547.0	10040.0**	4505.0
Institutional Factors										
Type of degree									2192.0*	1282.0
Program									7643.0**	3184.0
Has mentor in 1995 96									-5850.0*	3051.0
Belongs to research group									427.0	2209.0
R has funding concerns									-1778.0	1938.0
Intercept	47802.0***	1845.0	45477.0***	2932.0	33793.0***	10991.0	-10152.0	19010.0	-20294.0	19607.0
Adjusted R^2	.04		.05		.06		.10		.12	
F	3.27***		2.22**		2.04**		2.36***		2.41***	

SOURCE: Derived by authors from Fall 1995 Graduate Experience Project data. *** p < .01, ** p < .05, * p < .10.

Table 6. **Estimated Coefficients of Hierarchical Logit Models Predicting First Year Graduate Students' Expectations of Finding a Job in Field on Completion of Degree**

	Model 1 (n = 289)		Model 2 (n = 289)		Model 3 (n = 271)		Model 4 (n = 266)		Model 5 (n = 266)	
	B	Antilog	B	Antilog	B	Antilog	B	Antilog	B	Antilog
Demographic Characteristics										
Gender of R	-.07	.93	-.18	.83	.07	.93	-.21	.81	-.17	.85
Minority status	.27	1.31	.25	1.29	.35	1.41	.30	1.35	.24	1.27
Foreign status	-.80***	.45	-.96***	.38	-.90***	.41	-.99***	.37	.83**	.44
Marital status	-.13	.88	-.06	.94	-.08	.93	-.11	.90	-.21	.81
Employment status in 1995-96	-.37	.69	-.29	.75	-.34	.71	-.42	.66	-.12	.89
Background Characteristics										
Mother has college degree			.04	1.04	-.09	.92	-.07	.93	-.09	.91
Father has college degree			.44	1.55	.51	1.67	.45	1.57	.51	1.75
Mother is scientist/engineer			.99*	2.69	.73	2.07	.62	1.87	.72	2.06
Father is scientist/engineer			-.77**	.46	-.69*	.50	-.67*	.51	-.69*	.50
Lower/working class status			.08	1.08	.15	1.16	.12	1.13	.27	1.31
Upper class status			.75*	2.12	.59	1.80	.56	1.76	.31	1.37
Mother is employed			.18	1.20	.04	1.04	.06	1.06	.15	1.16
Undergraduate/Post BA Preparation										
Undergraduate GPA (4.0 scale)					-.79*	.45	-.88*	.42	-.81	.44
Self rating of undergraduate preparation					1.02***	2.78	.98***	2.66	.91***	2.47
Holds MA degree					-.72*	.49	-.67	.51	-.43	.65
Post-BA work experience					.15	1.16	.21	1.23	.36	1.44
Student Expectations										
Student expectations re: faculty/student interactions							.04*	1.04	.05**	1.06
Student perception of gender as liability							.70	2.02	.43	1.54
Student perception of race as liability							-1.43*	.24	-1.41*	.25
Institutional Factors										
Type of degree									-.02	.98
Program									.94*	2.55
Has mentor in 1995-96									-.10	.90
Belongs to research group									-.79**	.46
R has funding concerns									-.61*	.54
Intercept	.86***		.45		2.89*		-1.41		-3.56	
-2 log-likelihood	378.749		364.824		326.105		314.883		302.835	

SOURCE: Derived by authors from Fall 1995 Graduate Experience Project data. *** p<.01, ** p<.05, * p<.10

Table 7. **Estimated Coefficients of Hierarchical Logit Models Predicting First Year Graduate Students' Expectations of Limited Opportunities for Career Advancement**

	Model 1 (n = 282)		Model 2 (n = 282)		Model 3 (n = 266)		Model 4 (n = 261)		Model 5 (n = 261)	
	B	Antilog	B	Antilog	B	Antilog	B	Antilog	B	Antilog
Demographic Characteristics										
Gender of R	-.18	.83	-.17	.84	-.04	.96	-.01	1.01	.01	.99
Minority status	.68	1.98	.77	2.15	.75	2.12	.76	2.13	.90	2.45
Foreign status	1.42***	4.13	1.39***	4.02	1.51***	4.52	1.47***	4.36	1.17***	3.22
Marital status	.19	1.20	.20	1.22	.18	1.19	.23	1.26	.31	1.36
Employment status in 1995-96	-.27	.76	-.27	.76	.26	.77	-.23	.80	-.81**	.44
Background Characteristics										
Mother has college degree			-.23	.79	-.32	.72	-.37	.69	-.38	.69
Father has college degree			.67	1.95	.61	1.84	.62	1.85	.59	1.80
Mother is scientist/engineer			.04	.96	.17	1.18	.18	1.20	.11	1.11
Father is scientist/engineer			-.27	.76	-.18	.83	-.22	.80	-.47	.63
Lower/working class status			.86**	2.36	.80*	2.23	.89*	2.42	.67	1.96
Upper class status			.10	.91	-.04	.96	.03	1.03	.34	1.41
Mother is employed			.68*	.51	-.56	.57	-.59	.55	-.70*	.50
Undergraduate/Post BA Preparation										
Undergraduate GPA (4.0 scale)					-.18	.83	-.12	.89	-.58	.56
Self rating of undergraduate preparation					-.35	.70	-.26	.77	-.04	.96
Holds MA degree					.33	1.38	.24	1.27	.70	2.02
Post BA work experience					.02	1.02	.01	1.01	-.25	.78
Student Expectations										
Student expectations re: faculty/student interactions							-.01	.99	-.02	.98
Student perception of gender as liability							-1.73	.18	-1.45	.23
Student perception of race as liability							1.37*	3.94	1.46*	4.32
Institutional Factors										
Type of degree									-.52*	.59
Program									-2.59***	.08
Has mentor in 1995-96									-.58	.56
Belongs to research group									1.10**	2.99
R has funding concerns									1.59***	4.90
Intercept	-1.87***		-1.86***		-1.17		-.81		4.62	
-2 log-likelihood	274.811		266.23		251.429		245.896		215.680	

SOURCE: Derived by authors from Fall 1995 Graduate Experience Project data. *** p<.01, ** p<.05, * p<.10

Table 8. **Estimated Coefficients of Hierarchical Logit Models Predicting First Year Graduate Students' Expectations of Experiencing Family/Work Conflicts on Completion of Degree**

	Model 1 (n = 283)		Model 2 (n = 283)		Model 3 (n = 267)		Model 4 (n = 262)		Model 5 (n = 262)	
	B	Antilog	B	Antilog	B	Antilog	B	Antilog	B	Antilog
Demographic Characteristics										
Gender of R	.32	1.37	.44	1.55	.42	1.52	.41	1.51	.39	1.48
Minority status	.20	.82	-.07	.93	-.19	.83	-.24	.79	-.12	.88
Foreign status	-.53	.59	-.52	.59	-.18	.84	-.25	.78	-.37	.69
Marital status	.86***	2.36	.91***	2.48	1.23***	3.43	1.30***	3.68	1.37***	3.93
Employment status in 1995-96	.13	1.14	.17	1.19	.21	1.24	.24	1.27	-.03	.97
Background Characteristics										
Mother has college degree			-.39	.68	-.43	.65	-.48	.62	-.46	.63
Father has college degree			.23	1.26	.08	1.08	.12	1.12	-.05	.95
Mother is scientist/engineer			-.85	.43	-.78	.46	-.77	.47	-.69	.50
Father is scientist/engineer			.08	1.09	.09	1.09	.08	1.08	.11	1.12
Lower/working class status			-.19	.83	-.36	.70	-.33	.72	-.48	.62
Upper class status			-.34	.71	-.28	.76	-.26	.77	.02	1.02
Mother is employed			-.51	.60	-.32	.73	-.35	.70	-.50	.60
Undergraduate/Post BA Preparation										
Undergraduate GPA (4.0 scale)					.52	1.69	.57	1.76	.41	1.51
Self-rating of undergraduate preparation					-1.05***	.35	-.99***	.37	-.91**	.40
Holds MA degree					-1.07*	.34	-1.15**	.32	-1.63**	.20
Post-BA work experience					-.02	.98	-.04	.96	-.13	.87
Student Expectations										
Student expectations re: faculty/student interactions							.01	1.01	-.01	.99
Student perception of gender as liability							-1.16	.31	-.96	.38
Student perception of race as liability							1.05	2.85	1.02	2.76
Institutional Factors										
Type of degree									.24	1.27
Program									-.72	.49
Has mentor in 1995-96									.03	1.03
Belongs to research group									.49	1.62
R has funding concerns									.27	1.31
Intercept	-1.35***		-.92**		-2.39		-3.10		-1.47	
-2 log likelihood	299.587		291.899		269.107		265.538		257.373	

SOURCE: Derived by authors from Fall 1995 Graduate Experience Project data. *** p < .01, ** p < .05, * p < .10

Appendix A. Comparison Statistics for Fall 1995 Cohort and Sample Respondents

Selected Characteristics	Fall 1995 Cohort	Sample Respondents
Total	589	289
Percent female students	19.9	25.0
Percent international students	41.0	36.0
Percent in Engineering	88.5	83.0
Percent in Ph.D. programs	29.5	31.1
GRE Math score	743	740
Undergraduate GPA	3.5	3.5
Response Rates		
Overall response rate (%)		49.1
Response rate - males (%)		46.2
Response rate - females (%)		60.1
Response rate - U.S. students (%)		53.8
Response rate - international students (%)		43.4
Response rate - Engineering (%)		47.4
Response rate - Physical Sciences (%)		61.8
Response rate - in M.S. programs (%)		48.3
Response rate - Ph.D. programs (%)		52.3

SOURCE: Derived from Fall 1995 Graduate Experience Project data and data extract provided by The School of Graduate Studies.

APPENDIX B. Variable Definitions

Variable	Definition
Outcome Measures	
Academic self-confidence	A 6 -item measure based upon the Cooperative Institutional Research Program (CIRP) scale which asked student to rate academic abilities relative to the abilities of peers (see Astin and Sax, 1994). Using a scale from 1 to 10 with 10 indicating ability in the top 10% and 0 indicating ability in the bottom 10%, student rated general academic ability, analytical and problem-solving skills, critical thinking ability, writing skills in English, mathematical abilities, and computer skills. Overall scores ranged from 0, indicating a self-rating of ability in the lowest 10% of peers on all items, to a high of 60, indicating a self-rating of ability in the highest 10% of peers on all items.
Academic self-efficacy	A 10-item measure which asked student to indicate level of confidence relative to the completion of a series of degree-related tasks ("completing your degree", "completing your degree in a timely manner", completing your degree at this university", your ability to pay for your graduate training", "your knowledge about degree requirements", "your ability to maintain a balance between school and your personal life", "your ability to handle the course work", "your ability to conduct research", "handling the stress related to graduate work", and "your ability to do well in your program"). Responses were coded "2" for very confident, "1" for somewhat confident, and "0" for not confident at all.
Expected annual salary upon completion of degree	Student expected annual earnings, in US dollars, after completing current degree program.
Expect to find a job in field of study	Student expectation of finding a job related to current field of study after graduating coded as a dichotomous variable: 1= yes; 0 = no.
Expect limited opportunities for career advancement	Student expectation of having limited opportunities for career advancement coded as a dichotomous variable : 1 = yes; 0 = no.
Expect to experience family/work conflicts	Student expectation of experiencing family/work conflicts on completion of degree coded as a dichotomous variable: 1 = yes; 0 = no.

Predictor Measures

Demographic Characteristics

Gender	A dummy variable coded: 1 = female; 0 = male.
Minority status	Derived from responses to three survey items: place of birth, racial identification, and Hispanic origin identification. Coded as a dummy variable: 1 = non-minority; 0 = minority.
Foreign status	Derived from responses to two survey items: place of birth and residency status for enrollment purposes. Coded as a dummy variable: 1 = foreign; 0 = non-foreign.
Marital status	A dummy variable coded: 1 = married or living with a partner; 0 = divorced, separated, widowed or never married.
Employment status in 1995-96	A dummy variable coded: 1 = currently employed either off- or on-campus (as a graduate assistant, research assistant, teaching assistant or other); 0 = not currently employed.

Background Characteristics

Maternal education	A dummy variable coded: 1 = completion of bachelor's degree or higher; 0 = completion of less than a bachelor's degree.
Paternal education	A dummy variable coded: 1 = completion of bachelor's degree or higher; 0 = completion of less than a bachelor's degree.
Maternal occupation	Employment as a scientist or engineer coded as a dummy variable: 1 = mother employed as a scientist or engineer; 0 = all other occupations.
Paternal occupation	Employment as a scientist or engineer coded as a dummy variable: 1 = father employed as a scientist or engineer; 0 = all other occupations.
Lower/working class status	Respondent self-report of family socioeconomic status coded as a dummy variable: 1 = family of origin is of lower/working class socioeconomic status; 0 = family of origin is of middle class socioeconomic status or higher.
Upper class status	Respondent self-report of family socioeconomic status coded as a dummy variable: 1 = family of origin is of upper class socioeconomic status; 0 = family of origin is of middle class socioeconomic status or lower.
Maternal employment	Employment status of mother coded as a dummy variable: 1 = mother is employed outside the home; 0 = mother is not employed outside the home.

Undergraduate/Post BA Preparation

Undergraduate grade point average	Student self-report of overall cumulative grade point average, on a 4.0 scale, at time of completion of undergraduate degree.
Undergraduate preparation	Student perception of the adequacy of his/her undergraduate academic preparation ("how well do you think that your undergraduate education has prepared you for your graduate program") coded as a dichotomous variable: 1 = "very well"; 0 = "well" to "not well".
Completion of master's degree	A dichotomous variable coded as: 1 = student has completed a master's degree; 0 = student has not completed a master's degree.
Post-BA work experience	Student involvement in a post-BA work experience related to proposed field of graduate study, including paid employment, internships, cooperative work experiences, and volunteer experience. Coded as a dummy variable: 1 = has post-BA related work experience; 0 = has no post-BA related work experience.

Student Expectations

Student expectations re: faculty/student interactions	A 15-item measure of student entering expectations of department faculty in terms of: contributions to the field; teaching effectiveness; research expertise; advising skills; accessibility to students; supportiveness; formality; cooperation; fairness; approachability; friendliness; interest in student's ideas; willingness to share personal values and experiences; willingness to provide opportunities for professional development; interest in student as a person. For each set of paired traits (e.g. effective teacher versus ineffective teacher), student rated faculty on a scale from 1 to 7, with 1 indicative of more positive expectations (e.g. effective teacher). Overall scores could range from a low of 90 to a high of 120.
Student perception of gender as liability	Based on a 17 item scale from Astin and Sax (1994), student indicated whether he/she thought his/her gender status was an asset, ability or non-operative factor in being admitted to graduate school. Coded as a dummy variable: 1 = gender was a liability to admission; 0 = gender was an asset or had no effect on admission.
Student perception of race as liability	Based on a 17 item scale from Astin and Sax (1994), student indicated whether he/she thought his/race race or ethnic status was an asset, liability or non-operative factor in being admitted to graduate school. Coded as a dummy variable: 1 = race/ethnicity was a liability to admission; 0 = race/ethnicity was an asset or had no effect on admission.

Institutional Factors

Type of degree	A dummy variable indicating whether student was enrolled in a master's degree program or doctoral program: 1 = doctoral degree; 0 = master's degree.
Program	A dummy variable constructed to indicate whether student was enrolled in the physical sciences or in an engineering program: 1 = engineering; 0 = chemistry, physics, or applied physics.
Has mentor in 1995-96	A single item indicating whether student had a faculty mentor in graduate program: 1 = had a faculty mentor; 0 = did not have a faculty mentor.
Belongs to research group	A single item indicating if student belongs to a research group within department: 1 = belongs to a research group: 0 = does not belong to a research group.
R has funding concerns	Student degree of concern about the level of funding ("do you have any concern about your ability to finance your graduate training"), coded as a dummy variable: 1 = some or major concern; 0 = no concern.